

## Plot the Path into the Harbor

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**Subject/Grade:** Grade 3-6, Math, Social Studies, Science

**Duration:** 35 minutes

**Lesson Overview:** Students will use determine the best path for their ship to enter a harbor or river system from open water using a plastic shoebox as a model of a water body. Students use a wooden skewer to determine the water depth at different coordinate locations. The water depth readings will tell the ship captain whether the ship can safely pass through without running aground or hitting submerged obstructions which could damage the ship's hull or cause delay.

### Learning Objectives:

*After the lesson, students will be able to:*

1. Use coordinates to describe a specific location.
2. Identify potential maritime hazards: rocks, shoals, shallow water, islands, other ships, shipwrecks.
3. Determine the safest route for a ship to follow into the harbor.
4. Compare the topography of a lake bottom to the topography of the Earth's surface.
5. Define new shipping terms: aids to navigation, bathymetry, beacons, buoys, cartographers, charts, dredging, sonar.
6. Give examples of "aids to navigation" used to provide safe passage for ships and the people and cargo they transport.

### Materials Needed:

*Per class:*

- *Day the Great Lakes Drained Away* by Charles Ferguson Barker (or other illustration of the topography of a lake or ocean bottom).
- Nautical chart showing entry into a harbor.
- Road map
- Pictures of aids to navigation (3-5): green and red buoys, lighthouse, range light, nautical chart, fog horn, etc.
- Filler: poster of ship and labels

*Per student group:*

- Cardboard shoe box
- Spray foam insulation, wooden blocks, or egg cartons to make a varied bottom.
- 12" wooden skewer
- Marker
- Ruler
- 2 cm grid paper (with x- and y-axis labeled) ; newsprint paper to cover the top of the shoebox.
- Scotch tape
- Red & green washable markers

## Background

**U. S. Aids to Navigation** are “Road Signs” or markers along the waterways of the United States and its territories to assist navigation. This system employs a simple arrangement of colors, shapes, numbers and light characteristics to mark navigable channels, waterways and obstructions.

<http://www.uscgboating.org/ATON/index.html>

Aids to Navigation can provide a boater with the same type of information drivers get from street signs, stop signals, road barriers, detours and traffic lights. These aids may be anything from lighted structures, beacons (lighthouses), day markers, range lights, fog signals and landmarks to floating buoys. Each has a purpose and helps in determining location, getting from one place to another, or staying out of danger. The goal of the U.S. Aids to Navigation System is to promote safe navigation on the waterway.

The U.S. Aids to Navigation System is intended for use with **Nautical Charts** (maps of waterways). Nautical charts are essential for safely navigating waterways. Charts show the nature and shape of the coast, buoys and beacons, depths of water, land features, directional information, marine hazards and other pertinent information.

National Oceanic and Atmospheric Administration (NOAA) creates the nation's nautical charts. NOAA hydrographic survey ships scan the sea floor to identify navigational hazards and obstructions while also acquiring water depth data.

**Bathymetry** provides a detailed representation of the topography of the ocean or lake floor. Because **cartographers** (map-makers) cannot directly observe the bottom, they use sonar (bouncing sound waves off the ocean floor and measuring the time it takes to return).

The U.S. Aids to Navigation System includes **beacons** and **buoys**. **Beacons are aids to navigation structures that are permanently fixed to the earth's surface. They range from lighthouses to small, single-pile structures** and may be located on land or in the water. **Buoys are floating aids that come in many shapes and sizes.** They are moored to the seabed by concrete sinkers with chain or synthetic rope moorings of various lengths connected to the buoy body. They are intended to convey information to the boater by their shape or color, by the characteristics of a visible or audible signal, or a combination of two or more such features.

**Advance Lesson Preparation** (how to make shoebox models)

Each student group (or the teacher) will make a shoebox model of a lake/ocean bottom.

First, draw a safe passage route into the harbor on the inside bottom of the box. Next, spray insulation foam or place wooden blocks, overturned egg cartons, or other objects to create obstructions to a ship's movement *outside* the safe passage route. The objects are randomly arranged on the bottom and taped to the bottom to avoid objects shifting. Next, cover the top of the shoebox with a sheet of newsprint and secure with tape. Lastly,

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tape 2-cm grid paper (with x- and y-axis labeled) onto the paper over the opening. Note “open water” at one end and “harbor” at the opposite end.

### **New Terms**

Aids to Navigation – any marker along the waterways of the United States used to warn boaters and ship captains of navigational dangers.

Bathymetry – the topography of the lake or ocean bottom.

Beacons - structures that are permanently fixed to the earth's surface, such as lighthouses, to warn of navigational hazards.

Buoys – floating aids that come in many shapes, sizes, and colors representing different information to the boater.

Cartographers - map-makers

Charts - maps of waterways used by recreational boaters and ship captains

Draft - the vertical distance between the waterline and the bottom of the hull (keel). Draft determines the minimum depth of water a ship or boat can safely navigate.

Dredging – removal of channel bottom materials to deepen navigational channels to allow safe ship passage. Dredging may disturb aquatic ecosystems by disrupting bottom-dwelling organisms, and expose contaminated sediments previously buried on the lake bottom.

Sonar - a technique that uses sound waves (usually underwater) to navigate, communicate or detect other vessels (**SO**und **NA**avigation and **R**anging).

### **PROCEDURE**

**Introduce yourselves**---name, major, university, types of jobs people with your degree can do. **(2 min)**

#### **Attention Getter (3 min.)**

How many of you have ever been on a boat? How many have seen a ship? How do ships know where to go? How do they keep from running aground or into an obstruction?

#### **Activity Steps**

1. Show some drawings of the bottom of a lake from the book *The Day the Great Lakes Drained Away*. The bottom of lakes and oceans looks a lot like what we see on land---there are mountains, ridges, valleys, and plains. These would be revealed if all the water was drained away. These **landforms** can be obstructions to ships. **(3 min.)**

2. Display a **nautical chart** and compare to a highway map. Tell students that nautical charts are the “road maps” of waterways used by recreational boaters and ship captains to determine safe passage on lakes and oceans. Ask students “What else besides land-forms might obstruct a ship’s safe passage? *Shoals, sediment, shipwrecks, rocks, islands, etc.* Shipping lanes into harbors are often dredged to allow safe passage. **(2 min.)**
3. Using a nautical chart, show the locations of lighthouses and off-shore buoys that warn ships of shallow water or obstructions. These are called ‘**Aids to Navigation**’ and are used to warn ship captains of dangerous areas in order to protect people, ships, and the cargo they transport. Other examples of aids to navigation are: lighthouses, fog horns, etc. Buoys serve as “traffic signals” to guide vessel operators safely along waterways (<http://www.boat-ed.com/mi/handbook/toc.htm>) Show pictures of some aids to navigation. **(4 min.)**
4. Students and parents will be surveyors and work in teams (2-4 people) to measure the depth of the water to find a safe route into the harbor. Distribute the shoeboxes to each group. Show students that they will start from “open water” (the ocean or lake) and travel into the “harbor” marked at the opposite end. Students should draw a colored line on their skewer to indicate safe water depth for their ship to safely move through the water. A safe depth is when the skewer reaches all the way to the bottom of the shoebox. This survey information is used by **cartographers** (map makers) to make nautical charts. **(2 min.)**
5. Whenever the skewer hits an obstacle, the water is too shallow. Circle that coordinate point **red** on the grid paper for **STOP!** If the skewer reaches to the bottom with no obstruction, circle that coordinate point **green** for **GO!** Shipping lanes must be at least 1” wide to allow the ship through. Encourage students to take turns moving the skewer, checking the water depth, and circling the coordinate, as they move across the paper. **(10 min.)**
6. The instructor can ask a group to come up and carefully remove the paper--- by cutting with scissors where the tape is--- to show what it looks like under the paper and whether the group found the best route into the harbor. **(1 min.)**

**Filler:** Let’s see if we label the parts of a ship on this poster.

### **Assessment of Student Learning (5 min.)**

*To assess student understanding, ask:*

1. Give examples of possible maritime hazards: rocky shorelines, shoals, shallow water, islands, other ships.
2. How can we tell how deep the water is and whether there are any obstructions?
3. Compare the topography of a lake bottom to the topography of the land surface.

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4. Define new shipping terms: aids to navigation, bathymetry, beacons, buoys, cartographers, charts, dredging, sonar.
5. Give examples of “aids to navigation” used to provide safe passage for ships and their passengers and cargo.

### **Final Thought**

Nautical charts (maps of waterways) and Aids to Navigation are essential for safely navigating waterways, and transporting people and cargo all over the world.

### **Clean Up**

Ask students to put their boxes, skewers and markers where you tell them.

### **Extension**

Make a bathymetric map (the “water” version of a topographic map) of the entire shoebox, noting the water depth at every coordinate.

### **References**

Maritime Heritage Educational Resource Guide: Great Lakes Lighthouse Keepers Assoc. 1998.

U.S. Aids to Navigation <http://www.uscgboating.org/safety/aton/system.htm>

National Oceanic & Atmospheric Administration <http://www.noaa.gov/charts.html> and <http://www.history.noaa.gov/>

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